

Using Guiding Lines for Increasing the Effectiveness of Images

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Abstract

One of the objectives in image synthesis is to create 2D-images. However, the properties of images are not usually used in the modelling process. This paper describes a work that takes into account the characteristics of images from the beginning of the design process. 3D-scenes are automatically created so that their visualisation respects the properties of images desired by the designer. We have implemented the management of guiding lines that draw the observer's gaze. The developed modeller automatically produces layouts of guiding lines from a description of the composition's nature. Since the designer selects one of the layouts, the modeller creates a set of 3D-scenes that lead to images respecting the given description.

Keywords: guiding line, spatial control, declarative modelling, gaze shifting

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ABSTRACT

One of the objectives in image synthesis is to create 2D-images. However, the properties of images are not usually used in the modelling process. This paper describes a work that takes into account the characteristics of images from the beginning of the design process. 3D-scenes are automatically created so that their visualisation respects the properties of images desired by the designer. We have implemented the management of guiding lines that draw the observer's gaze. The developed modeller automatically produces layouts of guiding lines from a description of the composition's nature. Since the designer selects one of the layouts, the modeller creates a set of 3D-scenes that lead to images respecting the given description.

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1 INTRODUCTION

In image synthesis, the creating process is composed of two steps: modelling and rendering. There has been much research about the latter, so we can currently produce very realistic images from a scene. The first step has less been studied and is often a long and tedious process. More and more, modellers take into account constraints related to the use of the objects from the beginning of the model creation. These constraints are about objects but they are rarely about obtained images. Well, images are as important as scenes. For many applications of image synthesis, the image is fundamental because it is the communication's medium. There exist many reading rules of images. The integration of them during the modelling phase allows the production of images that respect these rules, so images are more readable, more efficacious.

The gaze does not mechanically explore an image surface. From information obtained during a first exploration, the gaze reacts according to the nature of the represented objects, the lines that structure the image, and the present shapes. The way that an image is decoded has an impact on the way that image is emotionally perceived. According to photographers, a "good" image is one that drives the observer's gaze as a result of its composition²¹.

The work we present is about taking images' characteristics into account in the design process. The designer defines some properties of the images he requires. Then, the modeller computes automatically 3D-scenes so that their visualisation respects the images' properties given by the designer. Currently, the modeller handles properties that

have an effect on the composition of the 3D-scenes. More precisely, it handles guiding lines which are lines controlling the gaze shifting.

This paper is composed of four parts: the related work, the basic idea of our work, the generation of straight guiding lines and the generation of curved guiding lines.

2 RELATED WORK

2.1 Scientific Approach

The science of cognitive psychology attempts to provide explanations about the functions of the human brain. It includes the study of perception problems and eye movement. The reading of an image is not a continuous process. An image is read with a series of jerks going from one fixed area to another by short, rapid eye movements⁴. This working mode is not a conscious process. When the eyes explore a static image, the next movement depends on many variables like physical contrast (light, colour, geometry, etc) or like information (information already acquired, information looked in the scene for, etc). There exist many ways to explore an image. But, the eye movement process presents general features. Yarbus⁵ studied eye explorations with a mechanism that records eye movements during three minutes. The figure 1 presents a result of the experiments carried out. At the top and left corner, we can observe the reference image seen by different people. The other pictures stress the movements of their eyes. The recordings are different, but contain similarities. The curves followed by the eyes are nearly the same. The main one is going through the people's heads in the image. The people's bodies define others.

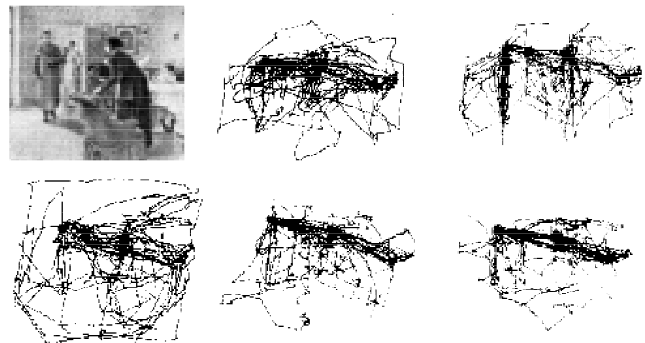


Figure 1: Eye movements of five people

The sequence of areas of focus corresponds to the attention centres that guide the observer to discover the environment.

The eye exploration is at the beginning of the perception process. It determines the content and the structure of information to be acquired. In other words, it determines the creation of the perceptive image.

2.2 Pragmatic Approach

Painters¹⁴ were probably the first people interested in the shifting of the gaze in order to bring the eye on to a target. Famous painters have known for a long time how to control the reading through paintings. To that end, they use precise rules knowingly or instinctively. The purpose of these rules is to facilitate the reading of images. Today, people from other professions, have the same preoccupations: persons who work in any artistic fields based on images (painting, photography, advertising, cinema, and cartoon). The study of these domains allows uncovering general rules that define links between an image and its reading. General rules are applicable to all fields based on images because they are connected to the human vision and to the eyes that explore and decipher the image surface.

Artists are rarely interested in eye physiology and vision phenomena². But, they have empirically discovered the natural tendencies of the eyes. For example, the gaze likes to move along horizontal lines. One reason for that is the position of the human eyes. On the contrary, the gaze dislikes moving along vertical lines because it needs more efforts to do that. The decoding of an image depends of our reading habits. In Western culture, reading is done by scanning from the left of the image surface to the right and from the top to the bottom. In Eastern culture, reading habits are different. Consequently, the decoding of an image can be different depending on the observer's origin. Thus, to better understand a Japanese print, we have to read it using Japanese reading habits.

The decoding method has a great impact on the way an image is emotionally perceived². An image that is very well composed induces the observer to analyse it successively, respecting an order¹ defined by the artist. So, artists have to control the movements of the observer's eyes and the path that the observer's gaze will follow. To achieve that result, they take into account the natural tendencies of the eye. They have also to use tricks to increase these tendencies or, on the contrary, to oppose them. One of these techniques is the use of guiding lines. The figure 2 shows two examples of guiding lines in two different artistic fields. Guiding lines define the secret skeleton of images. They are defined before carrying out the work. Often, they go unnoticed. The observer does not see them. Guiding lines drive the observer's gaze and they force it to follow a path defined by the artist. Guiding lines can be interrupted, can be cut and might not be rectilinear. Often, they are composed of groups of disparate elements which are along a virtual line (see the horizontal guiding line in the image of the figure 1). This virtual line has a sufficient continuity so that the eyes follow the defined path. Usually, an image does not contain more than two or three main guiding lines.

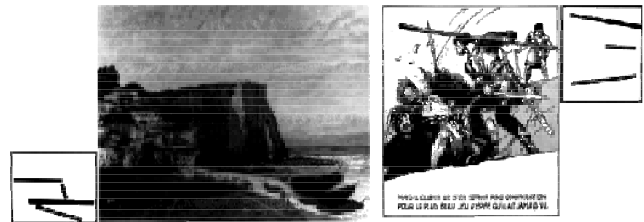


Figure 2: Guiding lines in painting¹⁶ and strip cartoon¹⁷ (extract from ²)

2.3 Computer Science

If physic laws are used everyday in image synthesis, the artistic knowledge is rarely used. However, we can note some works like one about virtual cinematographer³ in virtual reality, and another one about the rendering of frames which can influence people¹⁵. In these works, the artistic knowledge is used for the display of scenes but not for their modelling. It is very difficult with classical modellers to integrate this knowledge because they are composed of low-level tools. The modelling process is often manual, very long and fastidious. Classical modellers can not take into consideration high level constraints that the user would like to have in the scene. Currently, in the CAD domain, we can find new modellers¹¹ which allow the definition of constraints during the modelling step. For example, we can note the RacerX project¹³, and constraint-based modelling systems¹², etc.

In a larger domain than CAD, declarative modelling^{6,7,10} allows to create scenes giving only a set of properties and constraints which the scenes must respect (Fig. 3). The designer can have a "mental image" of an object that, for him, could be a solution. However, this image does not take part in the design process, and a declarative modeller has no use for it. From the description given by the designer, the modeller automatically builds a set of scenes that are in accordance with his request. It is obvious that it is not useful to apply validity tests to these scenes. However, as the modeller builds the scenes, the designer does not have a precise idea of their aspect. So, it is very important to give some efficient tools that allow him to understand the solutions and explore the solution set. After seeing the solutions, he may want to change the description given at the beginning. This is the design process stressed in figure 3.

In figure 3, the user's work corresponds to the light areas whereas the computer's work is in the grey ones. The location of the boxes shows who, the man or the computer, does the action. When the box is in the both areas, it shows how much work each of them has to do. This figure points out the amount and the kind of work done by a man. Declarative modellers are in charge of a more important part of the work than conventional modellers. This process allows a designer to restrict his work to higher-level tasks. So, the designer can concentrate on the creation process, instead of calculating the scene.

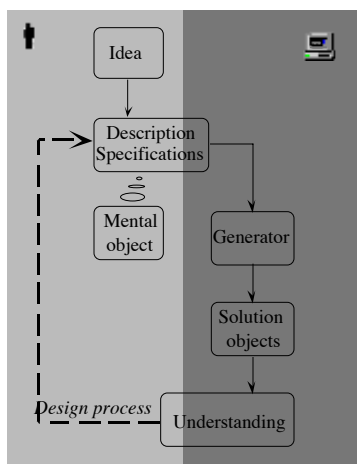


Figure 3: A declarative modeller

3 THE BASIC IDEA

Knowing the strong link between the image deciphering and the perception, we think it is important to integrate general rules of the image-based artistic domains in image synthesis. The main idea of this paper is to build guiding lines in order to induce the observer to decipher images the way the designer intended it. To this end, we can proceed two ways:

- *Photographer's method*: in this case, we suppose that the scene is already modelled. As a photographer does when taking a picture, we look for an angle which reveals guiding lines. We have to compute an image with guiding lines from a scene that we can not completely change. Sometimes, it is only possible to slightly modify the scene but nothing more. Therefore, the scene limits us. Strothotte⁵, He³ and Jardillier⁹ followed this approach which leads to the creation of displaying tools.
- *Painter's method*: Painters can have an effect on the composition of the scene. They have extensive liberty when they paint an imaginary space. On the contrary, when they reproduce a real scene they are restricted especially if they want to demonstrate a great degree of precision. Then, they experience the same problems as photographers. Therefore, the painter's method is excluded. The context of this approach is the design of new scenes. During the scene-modelling step, we take into account the designer's constraints and the general rules relating to guiding lines. This approach leads to the creation of modelling tools.

We have chosen the second method because it offers greater control in obtaining very well-composed images. To implement it, we need to use modelling that can take constraints into account from the beginning of the modelling. This explains why we are working with a declarative modelling approach. The designer gives a description of the ob-

jects of the 3D-scene, constraints on the objects, and a description of the kind of guiding lines he wants to see in the 2D-image. The problem we must solve is to build automatically 3D-scenes whose visualisation agrees with the given description. In other words, the images are composed with the intended guiding lines. Contrary to the usual approach, we begin to focus on the observer's position. Each scene is built according to the fixed position and the description of guiding lines. This process is a type of spatial control.

4 GUIDING LINES

To achieve the first release of the modeller, we have considered some restrictions. First, we have chosen to generate landscape scenes, including a limited set of objects: different trees from shrubs to poplars, houses, barriers, ways, and hills (see the scene examples in figures 8, 9, 10, 11). These objects are simply modelled. Additionally, we assume that the ground is an infinite plane. All objects are lying on it. Object alignments create the guiding lines. Most of the time, this will produce interrupted guiding lines. Currently, we only place one kind of objects along a guiding line. They have slightly the same height. This is a limitation but provides some coherence in the objects' alignment. Besides, this kind of alignment frequently appears in landscapes: rows of trees, barriers, houses,...

Our modeller works according to a "draft path design"⁶ method allowing us to build scenes step by step. At each step, the amount of details increases, and scenes are built at a higher level. To create scenes, the designer begins by setting the properties of the desired guiding lines and objects. We assume that the designer knows roughly what kind of composition - in terms of guiding lines - he wishes to obtain. From these specifications, the modeller produces layouts of 2D-guiding lines that correspond to the description. Then, the designer chooses one of them that will constitute the draft of the future scenes. From the selected layout, the modeller automatically creates a set of 3D-scenes that are in accordance with the description. In other words, the scenes are composed of selected objects. Moreover, the visualisation of the scenes produces images whose guiding lines agree with the given properties.

Below, we describe the different stages of modelling: the description of images, the generation of 2D-guiding lines, and the placing of the 3D-objects according to the guiding lines.

4.1 Description of the Image

From the observation of photographs and paintings, some characteristic compositions emerge. We can sort images according to sets of underlying layout. Therefore, the description phase is such that the designer can describe the kind of composition he expects.

The first property we have chosen to use is the orientation of the lines. The orientation is one of the most expressive features of the guiding lines. We first defined the “horizontality” measure, which we think to be more relevant to the designer than the orientation. In this manner, using a specific graphic interface, he has just to determine if the guiding lines have to be more or less horizontal, vertical, or oblique. Another property is the convergence of the lines towards a given point in the image. Thus, we defined a convergence measure. This gave us to create compositions in which the guiding lines globally converge towards a chosen point. Afterwards, if the designer decides to place a main element in the composition, it is placed by default at this convergence point. However, to obtain a particular effect, he can deliberately place the main element anywhere else in the image using a pointer device. In that case, guiding lines do not converge any more towards the main element.

Convergent lines are useful when the eyes are not naturally attracted by the main element. The “Rule of Thirds”^{1, 2} gives four main points of attraction in an image (figure 4). An object is naturally emphasised when it is placed in one of these four points. Convergent guiding lines allow us to place the main element anywhere else in the image. In fact, they draw the observer’s gaze to it. Therefore, the main element remains emphasised, even if the image contains other attractive elements.

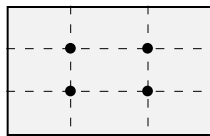


Figure 4: The four main points of attraction in images.

These two properties allow us to describe the behaviour of the gaze compared to the main element: it may be strongly attracted to, or not attracted to this object. They also allow us to describe the global behaviour of the gaze. Using the horizontality property, we can encourage horizontal reading, or force vertical or anarchic reading. Using the specific graphic interface, the designer describes the properties of the guiding lines. Moreover, he can define other parameters before the generation of the scenes. The objects that can or can not appear in the scenes may be selected. The position of the horizon can be chosen in the image. Often, the horizon represents an important additional guiding line. The user can place this additional line wherever he wants, or push it outside the frame. Moving the horizon is also a way of changing the camera’s orientation. This method offers views from below or from above. The designer can specify the observer’s height, that is, the camera’s altitude. We can obtain low altitude views (a shot close to the ground) to high altitude views (a plane shot). Note that the camera parameters are set before the scene generation. Camera settings affect the position of objects in the scene, while guiding lines do not change position in the image.

4.2 Generation of the 2D-Guiding Lines

After the description phase, the modeller has to compute layouts of guiding lines that correspond to the description given by the designer. To do that, we have to explore the universe of all possible 2D-lines. As the position of guiding lines does not need to be very precise, the universe can be limited. We use a grid, more or less fine, the line extremities can be placed on. So, we explore the set of lines whose the extremities are on the grid points. Because an image only contains few guiding lines, the set of all possible layouts is finite and not very large. Therefore, we can compute all the solutions by building an enumeration tree¹⁹. Each node of the enumeration tree represents a possible set of lines. A child is created from a node by adding a new line. The depth of the tree is limited by fixing the maximum number of lines in a solution. A branch is cut when the last added line does not correspond to the description. That is to say, the horizontality measure or the convergence measure of the last added line is not in the acceptance intervals that represent the validity domain of the properties. Moreover, we invalidate the current branch if the last added line intersects another one: in fact, two guiding lines do not usually intersect in images (figure 5.a). One of the two lines, or both, is cut (figures 5.b, 5.c). So, we consider that these configurations are composed of three or four lines.

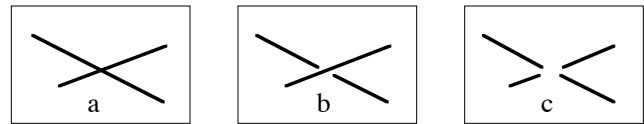


Figure 5: Intersection of two guiding lines

4.3. Placing the 3D-objects

We described how scene drafts are generated in accordance with the description of the guiding lines. At this stage of the modelling, the designer can choose any solution, and can start the generation of corresponding 3D-scenes. One of the main aspects of the scene generation is the transition from the 2D-plane to the 3D-scene. We must place objects inside the scene so that they appear along the image guiding lines. There are many ways to place these objects: each segment of the image generates a piece of plane in the scene, delimited by two straight lines. For instance, we could place the objects along any 3D-curves belonging to the plane and joining both straight lines. 3D-curves do not even need to be continuous. They could be declaratively described and generated²⁰.

We have previously supposed that the guiding lines are created by the alignment of similar objects. More precisely, a guiding line is formed by the succession of reference points of the objects. For example, the tops of trees are aligned. In this case, the top of trees is the reference point. We can also choose another one like the bottom. Because the objects along a guiding line have nearly the same height and

they lay on the ground, the succession of the reference points is a line parallel to the ground. To prevent any confusion with image horizontal lines, we will call it a “3D-horizontal” line. The placement of objects along such line can not give a guiding line that intersects the horizon. So, when a guiding line of the layout intersects the horizon, we consider that we have 2 guiding lines: one above the horizon and one below it.

The purpose is to create 3D-scenes from the layout selected by the designer. Instead of generating a subset of all possible “3D-horizontal” lines, we explore the object library, and, for each possible object type (tree, house,...), compute the corresponding line coordinates. In fact, there is a unique “3D-horizontal” line with a given height. Additionally, each object of the library has a predefined height. By knowing the height of the objects we have to place, it is possible to compute the line’s height in the scene. Obviously, the relation between the objects’ height and the line’s height depends on the way the objects are vertically placed. It depends exactly on the chosen reference point. For distant lines, if we fit the objects so that the guiding lines cross their centre (the reference point is the centre of objects), the visual result is satisfactory. However, nearby object alignments do not agree with the line as well, and object edges produce additional lines (figure 6).

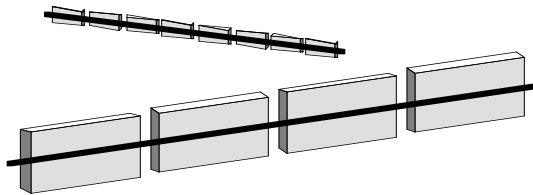


Figure 6: Influence of the objects distance on the guiding line effectiveness.

When the lines are above horizon, this problem becomes more important. Objects are taller, closer, and are generally cut (figure 7a). A good way to resolve this problem is to fit the objects so that the guiding lines pass through their top (the reference point is the top of objects - figure 7b). The objects are no longer cut, and they are more distant and more numerous. However, their base suggests another important guiding line.

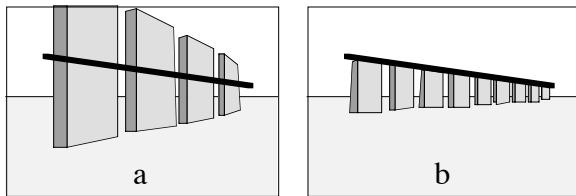


Figure 7: Two fitting methods for the same guiding line.

To obtain scenes that seem more natural, we chose the middle of objects as the reference point for the lines below horizon and the top for the lines above it. As stated above, for a given guiding line, there are as many possibilities as

objects in the library. For each possibility, the line height in the scene is computed and corresponds to the object height if the 2D-guiding line is above horizon, or half the object height in the other case. We have added two more implied conditions to provide some consistency in the scenes. For each kind of object, there is a minimum distance from the camera to prevent close elements from obscuring the scene. Moreover, there must be a minimum number of objects to form a guiding line. In particular, extremely short distances are not accepted. If these conditions are met the objects are placed in turn along the scene line in order to form an alignment. The way the objects are placed depends on their type: each object type has its own spacing and angle value. The angle value is the object angle along vertical axis, which refers to the scene line. It shows for instance if the objects must be placed along the line or perpendicular to it. To avoid alignments that are excessively regular and unnatural, we have added a controlled noise during the objects placing. Most of the object’s parameters are defined in intervals. Spacing and angle values can vary slightly along the line, inside predefined intervals. To prevent objects from leaving guiding lines, the angle variations along the line and the distance from the line are also kept in intervals. Moreover, the speed of angle variations is also controlled, in order to smooth the series of objects. Finally, we have added a little noise in objects dimensions, with a possible control on height variations. The height used to compute line coordinates is the medium height, i.e. the middle of the height interval. Each kind of object has its own intervals. The size of the intervals has an effect on the object behaviour during the placement. For instance, high control on the speed of angle variations produces nice winding paths. The height of the trees is defined in a relatively large interval, while the height variation is defined in a smaller one. Therefore, trees tops follow a curve like the natural tree alignments.

4.4 Results

Once the description is given, the generation of the layouts of guiding lines is a fast process. In fact, the grid we use is composed of 16x11 points. So, the exploration of the enumeration tree is only a few seconds long. The designer does not need to wait a long time before choosing a draft used to build images and scenes. Figures 8 and 9 show layouts of guiding lines and one of the generated 3D-scenes for two different descriptions. On the first one, the designer requested a rather horizontal composition. On the second one, he placed the main element near of the right edge of the image. This position is rather distant to one of the four main points of attraction. In order to help the observer to see the main element naturally, the designer wanted guiding lines that converge towards it.

Once the designer selected a layout of guiding lines, the modeller can build 3D-scenes in accordance with the description made and with the chosen draft. Currently, the generated scenes are only composed of elements that are along the guiding lines. As a result, the scenes do not seem very natural. However, the designer can request the

adding of chosen objects that increase the realism. These objects are randomly placed in the scenes. We do not control the adding of these objects in relation to the original design yet. Consequently, the image may no longer verify the original description. The figure 9 stresses the problems relating to the random object adding. The added tree in the foreground cuts one of the guiding lines of the layout. However, the observer can still see this line as if it was not cut. If a guiding line is widely covered up with additional objects, it can not be perceived, and the image is no longer in accordance with the draft. Furthermore, adding objects can change the main element of the image. The added tree is big enough, and is in the foreground, making it possible for it to become the main element. This is not the case in figure 9 thanks to the convergent guiding lines. If this tree was added in an image without any convergent lines, the main element would be the tree. Adding objects randomly does not completely interfere with the description; nevertheless, we plan to address this problem in the future works we will do. Meanwhile, the designer may ask to add other objects if he does not like the previous ones. Moreover, the designer can change some parameters (like the horizon position), or he can freeze some parts of the scene before launching another scene generation. This generates a new scene, similar to the previous one.

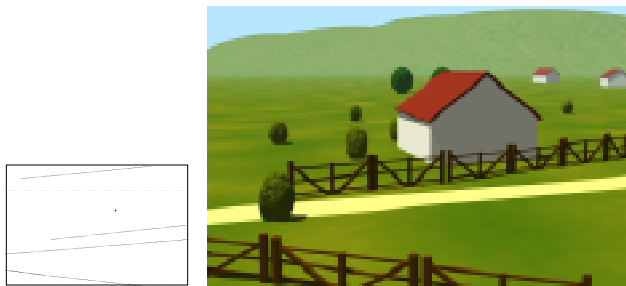


Figure 8: *A rather horizontal layout and a corresponding 3D-scene*



Figure 9: *A convergent layout and a corresponding 3D-scene*

Our modeller builds 3D-scenes so that their visualisation is in accordance with the described guiding lines. However, it is obvious that if we apply any rotations on the scene it would alter the guiding lines. In fact, it amounts to the same thing as moving the observer. Instead, all the elements of the scene have been placed in order to constitute guiding lines from a precise position.

5 CONTROL OF THE GAZE SHIFTING

In the previous part, the layouts of guiding lines are generated using segments. Thus, controlling the gaze behaviour is limited. In fact, we are able to produce images with guiding lines that are more or less horizontal, or those that are primarily convergent towards the main element. Yet, with such guiding lines, we can only control the global behaviour of the gaze; we can not manage the path that the gaze follows. In this part, we extend our method to take into account the path that the gaze has to follow during the image reading. Sometimes, the designer does not want the viewer's gaze to proceed directly to the main subject. In other words, he may want to delay the observer's discovery of the main element of the scene. Or, he may want to highlight the shape of one element before fixing the gaze on a target point. In this case, the shape defines the path that the gaze has to follow. The target point is generally the main element of the composition. Besides, reading paths start, more often than not, from a border of the image, because of the natural tendency of the eyes. Consequently, we have chosen to generate reading paths that start from a border, and finish at the main element.

There are a variety of ways to control gaze shifting with guiding lines. For example, we can use a series of straight guiding lines, one unique curved guiding line, or a set of curved guiding lines. For the first release of our modeller, we arbitrarily chose to use one unique curved guiding line. However, this line is split up every time it crosses the horizon line. Thus, we can describe paths that go through the horizon line.

5.1 Description of the Image

The image description must take the main features of gaze shifting into account. Two important aspects are the initial point and the target point. The way the image is read depends on the position of these points in the image. Moreover, there are many ways to join the initial point and the target point. The gaze can go directly from one point to the other, it can slightly curve round, or it can pass through another point of the image. In some compositions, the gaze can even be forced to turn around the target point, which produces some dynamism.

Using a pointer device, the designer manually places the target point in the image. By default, it represents the position of the main element. The way the gaze travels towards the main element is described with a syntax close to the natural language. The designer describes where the gaze starts in the image (this determines the initial point), and how it travels to the main element (this determines the curve's shape). He can also specify an intermediate point. Our modeller can parse a description like "The gaze starts from the left, goes to the top, then travels directly to the main element". We defined 9 different locations in the

image for the initial point and the intermediate point: “left”, “top”, “right”, “bottom”, “bottom left”, “bottom right”, “top left”, “top right”, and “undefined”. Besides, there are 5 different ways to describe the gaze behaviour: “undefined”, “the gaze arrives to the main element”, “... directly arrives to ...”, “... turns around...”, and “... makes n turns around ...”. n can be an integer or a fraction.

5.2 Generation of the Reading Paths

To achieve the first release of the modeller, we have limited the trajectory modelling to a class of curves in polar coordinates ($\theta = f(r)$). The origin is the target point. In this way, it is easy to define curves that turn around a target. In addition, straight or slightly curved lines can also be easily built. Straight lines to highly wound spirals can be generated using linear functions. Quadratic functions (“ $f(r^2)$ ”) and harmonic functions (“ $f(1/r)$ ”) allow us to have an additional degree of freedom. Quadratic functions can produce curves with a cusp. Harmonic functions produce curves without any cusps.

The curves are inside a circular envelope, which can easily go beyond the frame if the starting point and the target point are distant enough. Therefore, wound curves are not always in the image totally. So, the designer can act on an additional parameter, which allows him to modify the curve’s flatness applying a geometrical transformation.

Paths are generated from the description the designer has given. First, we have to convert the description into a set of parameters. The target point is known because the designer gives it explicitly. The initial point, the intermediate point, and the parameters of the equation’s curve are instantiated by analysing the given description. As the number of possible curves is infinite, we can not generate all of them. That is why, we use discrete intervals for each curve parameter. Then, we explore these subsets. In other words, we build a curve for each possible t-uple of parameters. For each curve, we evaluate if the parameter values are in the acceptance domains. Still, we are not sure that we obtain all kinds of a curve. Some undiscovered curves are close to some computed curves. As the position of paths does not need to be totally precise, these undiscovered curves are not crucial. However, at times we overlook curves that are very different from others. As this can prove to be a problem, we plan to explore this matter further. Meanwhile, if the designer likes none of computed curves, he can interactively modify one of them. The interface of our modeller allows him to change the value of any curve parameter and see modifications in real time.

5.3 Placing the 3D-Objects

3D-scenes are built from a path that is composed of one curved guiding line, or more if it crosses the horizon line. We convert each curve into a polyline. To place the objects, we use the same algorithm as seen before, except that it has been extended to guiding polyline’s layouts. The guiding lines are also 3D-horizontal, and, by knowing their

height, the corresponding scene lines can still be computed. As before, all kinds of 3D-objects from the library are placed, according to their height, along the polyline. As a result, different scenes are produced, all of which are in accordance with the description given by the designer.

5.4 Results

Once the description is given, the generation of reading paths begins. The modeller quickly generates paths in accordance with the description. Once he selects a path, the generation of 3D-scenes can begin. The generated scenes are only composed of elements that are placed along the path. These scenes do not seem very natural. As before, the designer can select one scene, and ask the modeller to automatically add elements. However, since these objects are randomly placed, we face the same problems as before. Figures 10 and 11 show two examples generated from a description of the gaze shifting. On the left of each figure, you can see a generated path in accordance with the description. On the right, you can see a corresponding 3D-scene to which the modeller has added random objects. By default, reading paths are computed so that they keep inside the frame. In figure 11 the designer has interactively modified the selected path so that it goes outside the frame. Even if the path is cut by the frame, the gaze follows it as if it was not cut. As the path cuts the horizon line, it is cut in three polylines. Objects of a same type are placed along each one. Some 3D-scenes are built with three kinds of objects along the reading path. The result is better. The scenes seem more natural. So, we plan to develop this idea in the future. We will place different kind of objects along each guiding line or along each polyline.



Figure 10: A path generated with the description: “The gaze starts from the left, goes to the top, then directly arrives to the main element” and a corresponding 3D-scene

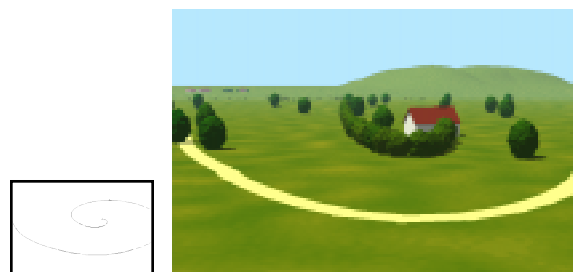


Figure 11: A path generated with the description: “The gaze starts from the left, then turns around the main element” and a corresponding 3D-scene

We can also note that the placement method should be connected to a knowledge database in order to produce a natural scene. Currently, the modeller has produced scenes that are not consistently realistic. For example, we can not find everyday a tree alignment similar to this one which corresponds to the third part of the reading path.

6 CONCLUSION

An image is a medium that contains a message defined by the designer and intended for the observers. We presented a work about scene modelling taking into account the designer's concept of the image. The image characteristics become the guidelines for designing the scene. These criteria define the way an observer reads and perceives the image. Using these criteria to design the scene, we can control the way that the designer conveys his message to the observer. In the end, there is less discrepancy between the designer's intended message and the message the observer eventually receives.

We have limited the first release of our modeller so as to test our approach as soon as possible. The images and the 3D-scenes created by our modeller stress the interest of our solution. We have developed a modeller that automatically builds 3D-scenes taking into account guiding lines from the beginning of the modelling phase. The aim is to generate images and corresponding 3D-scenes from a description and which respect the artistic knowledge databases on images. The designer can choose those he prefers and then modify selected images and 3D-scenes interactively.

In the future, we plan to continue our research by studying the unresolved problems described in this paper. We will add, in the scene design, constraints on and between 3D-objects of the scene. We will also extend the image's characteristics taken into account. Then, we will particularly have to do an experimental study on a large number of people to validate the described ideas.

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REFERENCES

- [1] Freeman M., "The great book of Photography", (in french), VM Editor, ISBN-2-86258-142-9, 1993
- [2] Duc, "The art of composition and centring - Painting, Photography, Cartoon, Advertising", (in french), Fleurus Idées Editor, ISBN 2 215 01864 X, 1993
- [3] He L., Cohen M., Salesin D., "The virtual cinematographer: A Paradigm for automatic Real-Time Camera Control and Directing", Proc. of Siggraph'96
- [4] Levy-Schoen A., "The study of ocular movements", (in french), Dunod Editor, 1969
- [5] Yarbus, "Eye Movements and Vision", New York, Plenum Press, 1967

- [6] Colin Ch., Desmontils E., Martin J.-Y., Mounier J.-P., "Working Modes with a Declarative Modeler", Compugraphics'97, Portugal, 1997
- [7] Lucas M., "Equivalence classes in object shape modeling", IFIP TC95/WG 5.10, Working Conference on Modeling in Computer Graphics, Tokyo, April 1991
- [8] Chauvat D., "The VoluFormes Project, an example of declarative modeling with spatial control", (in french), PhD dissertation, University of Nantes, France, 1994
- [9] Jardillier F., "An Declarative approach of camera movements", (in french), DEA report, University of Nantes, France, 1997
- [10] Kochhar S., "Cooperative Computer-Aided Design: A paradigm for automating the design and modeling of graphical objects", PhD dissertation, Harvard University, 1990
- [11] Design Interaction Paradigm home page <http://design-paradigms.www.media.mit.edu/projects/design-paradigms>
- [12] An electronic Primer on Geometric Constraint Solving, <http://www.cs.purdue.edu/homes/cmh/electrobook/intro.html>
- [13] The RacerX Project, http://robotics.eecs.berkeley.edu/~rbush/racerx.home_page.html
- [14] Dragicevic P., "Declarative modeling and reading guides in images", (in french), DEA report, Ecole des Mines de Nantes, France, 1997
- [15] Strothotte T., Preim B., Raab A., Schumann J., Forsey D., "How to Render Frames and Influence People", Eurographics'94
- [16] Courbet G. (1819-1877) "Falaise à Etretat par beau temps"
- [17] Harold Foster - "Prince Vaillant"
- [18] Desmontils E., Martin J.-Y., "Properties taxonomy in declarative modeling", Proc. of CISST'97, Las Vegas, 30 June -3 July, 1997
- [19] Pajot-Duval L., "Declarative modelling of segments", (in french), Proc. of 3IA'94, Limoges, France, 1994, pp 75-96
- [20] Daniel M., "Declarative modeling of fair shape: An additional approach to curves and surfaces computations", in "Advanced course on FAIRSHAPE, Hoschek J. and Kaklis P. (eds), B.G. Teuber Stuttgart 1996, pp 77-85
- [21] Boyard D. , "the small tricks which allows to obtain great images" (in french), "Chasseur d'images" journal, N° 180, Jan-Feb 96, pp 72-106

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